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Notes on the biology of *Mallada handschini* (Navás) and comparisons with other southern African species (Neuroptera: Chrysopidae)

by

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ABSTRACT

Aspects of the biology of *Mallada handschini* (Navás) were investigated in the Pietermaritzburg area of South Africa. Rearings were conducted under conditions approximating those in nature. The duration of the egg stage for *M. handschini* was compared to those of *Suarius squamosa* (Tjeder) and *Mallada baronissa* (Navás). These durations were found to be 8,1, 8,6 and 6,9 days respectively. The duration of larval stages of *M. handschini* were found to vary according to diet, although larval diet had no significant effect on the duration of the pupal stage.

INTRODUCTION

The habits and life histories of southern African Chrysopidae are poorly known: Barnes (1975) outlined the life history for *Chrysoperla zastrowi* (Esben-Petersen) and Brettell (1979 1982) gave details of the life histories of *Mallada boninensis* (Okomoto), *Chrysoperla congrua* (Walker) and *C. pudica* (Navás). This is a poor record, given that the total number of chrysopid species known in southern Africa is 79.

Although laboratory rearing data are difficult to relate to conditions in the field and are not comparable unless conditions are identical, some members of the family occurring in and around Pietermaritzburg were reared to further our understanding of southern African Chrysopidae. The species reared were *Suarius squamosa* (Tjeder), *Mallada baronissa* (Navás) and *Mallada handschini* (Navás), determined with reference to Tjeder (1966). The duration of the egg stage excepted, adequate data were only obtained for *M. handschini*.

The most abundant species collected was *M. handschini*, the female of which was previously unknown (Tjeder 1966). Furthermore, the species has previously been recorded only from the Cape Peninsula, Mozambique and Zaïre from dry fynbos and dense indigenous forest. The Pietermaritzburg specimens provide an intermediate locality between the Cape Peninsula and Mozambique, coming from suburban gardens and *Acacia* thornveld. Pietermaritzburg is also a new locality for *M. baronissa*.

MATERIALS AND METHODS

Imagos were collected in the suburb of Epworth, along the Blackborough Spruit, at Lynnfield Park at domestic lights and at a light-trap using a Mercury Fluorescent (MBFT/V) 230 volt, 160 watt light bulb. Larvae and pupae were also

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collected from these localities, as well as from the Botanical Gardens of Pietermaritzburg and a town center garden.

Captured imagos were placed singly in 90 mm diameter, plastic petri-dishes. They were supplied with the same artificial food mixture given to the larvae (see below). The eggs were incubated in the petri-dishes in uncontrolled temperature and humidity conditions. This was initially done with the intention that field conditions could be approximated, but it was later realised that this was probably not so. The maximum temperature varied between 14,0°C and 25,5°C (mean = 18,1°C; n = 105 days) and the minimum temperature between 5,0°C and 23,5°C (mean = 14,0°C; n = 105 days).

Newly emerged larvae were separated into individual petri-dishes to avoid cannibalism and reared under the same insectary conditions as the imagos and eggs. Larvae were fed on either five aphids, an uncounted number of aphids / day, or on artificial food. Although the uncounted aphids were inconsistent in number this method provided adequate nutrition for development; it was not necessarily optimal. This approach was used in an attempt to simulate field conditions, where larvae have an erratic diet. The alternative of five aphids / day was used to ascertain whether a regular diet might be preferable. Aphids were taken from rose bushes and were identified as: *Aphis gossypii* Glover, *Macrosiphum rosae* L. and *Rhodobium porosum* (Sanderson).

Artificial food was mixed according to the following recipe adapted from 'Diet 4: Federal Institute of Biological Pest Control, Darmstadt' for *Chrysopa carnea* (larvae) (D. Graham *pers. comm.*): 50 ml fresh milk, 1 egg, 5 g sugar or fructose, 15 g honey, 40 g wheatgerm, 40 g brewer's yeast. A blob (5–10 mm in diameter) was placed in each dish and replaced once dry (daily during hot weather).

Pupating larvae were left undisturbed. The emergent imagos were placed in pairs in petri-dishes in an attempt to induce mating within and between species. Artificial food was provided and longevity of the imagos recorded.

In the comparisons of durations of life stadia, data were normalised by 'Log x' transformations when the variance to mean ratio between tested pairs of data was found to be > 2,5. Student's t-tests and Analyses of Variance were all done using an unequal sample size technique in which variances were pooled. In tests where more than two samples were compared, the Analysis of Variance was supplemented by Duncan's new Multiple Range Test (Duncan 1955) (DMRT hereafter) to determine where significant differences occurred between all possible sample pairs in the test.

RESULTS AND DISCUSSION

The imaginal stage

Imagos of *M. handschini* fed the artificial diet survived for 9,1 days (n = 11, SE = 3,0, range = 1–27 days). The low value for 'n' does not imply that these were the only imagos to survive, but the only ones for which the length of the stadium was measured. Food mixtures other than the artificial diet were found to be unsuccessful, failing to sustain the imagos for more than a few days. Two imagos of *S. squamosa* survived for 34 days, suggesting that imagos can survive for much longer than the mean value recorded.

The egg stage

The duration of the egg stage was 8,1 days (n = 202, SE = 0,2, range = 4–18). This was compared to data collected under similar conditions for *S. squamosa* and *M. baronissa* (Table 1). An analysis of variance indicated that there were highly significant differences in the duration times of the different species ($p << 0,001$). The DMRT showed that at $p = 0,01$ *M. baronissa* had a significantly shorter egg period than *S. squamosa*. There was no significant difference in the time of egg development between *S. squamosa* and *M. handschini*, nor between the latter and *M. baronissa*.

The larval stage

M. handschini larvae provided five aphids / day had a mean larval period of 39,8 days (n = 16, SE = 3,1, range = 31–83; Table 2) which was significantly less ($0,01 < p < 0,05$) than that for larvae provided an uncounted number of aphids / day (57,1 days, n = 16, SE = 4,4, range = 16–92). The DMRT showed that there was no significant difference between the mean duration of either of the above

TABLE 1

Durations of egg stages (days) for three chrysopid species under uncontrolled laboratory conditions. Means sharing the same letter show non-significant differences at the p = 0,01 level.

Parameter	*Suarius squamosa*	*Mallada handschini*	*M. baronissa*
mean	8,6c	8,1bcb	6,9ab
n	109	202	62
SE	0,3	0,2	0,1
range	3–11	4–18	6–8

TABLE 2

Mean duration (days) of larval stages of *M. handschini* provided two food types. Means sharing the same letter show non-significant differences at the p = 0,01 level.

Stage	Parameter	5 aphids/day	Artificial food
Larva			
instar 1	mean	8,5a	14,5b
	n	19	14
	SE	0,3	0,5
	range	7–11	10–17
instar 2	mean	14,7c	14,8c
	n	18	6
	SE	0,8	0,7
	range	11–19	13–18
instar 3	mean	16,9d	9,8e
	n	16	6
	SE	3,3	0,8
	range	8–62	7–13
Total	mean	39,8f	43,4f
	n	16	14
	SE	3,1	1,6
	range	31–83	36–55

and that of larvae provided the artificial diet (43,4 days, n = 14, SE = 1,6, range = 36–55; Table 2). T-tests of the duration of larval stadia feeding on the artificial diet and on five aphids / day showed that the larvae developed faster in the first instar when fed aphids ($p << 0,001$), but faster in the third instar when fed artificial food ($p < 0,001$). There was no significant difference in the second instar. Third instar larvae possibly derived insufficient nutrients from the aphid food source. Aphids may constitute only part of the natural diet.

A number of larvae showed extended developmental periods. One larva of *M. handschini* reared on five aphids a day remained in the larval stage for 83 days (Table 3; compare with the mean (Table 2) of 39,8 days (n = 16; SE = 3,12), which includes this outlier, or 36,9 days (n = 15; SE = 1,54) excluding the outlier). This larva died after 62 days in the third instar. The duration of the first and second instars was found to be normal: 8 days and 13 days respectively (compare with Table 2). This extended third instar could be attributed to the build up of aphid siphuncular wax on the chrysopid head region. These waxes, extruded during stress, are probably multi-functional, having also been found to volatilise as alarm pheromones (Bowers *et al.* 1972), and perhaps acting physically to prevent predation (Strong 1967). The build-up of waxes may be the reason for a reduced mean number of aphids eaten / day (2,1, n = 83 days), which is significantly lower ($p << 0,001$) than the mean for 15 larvae of 2,9 aphids / day (n = 575 days). This reduction in number of aphids eaten / day occurred predominantly in the third instar ($p << 0,001$), while in the first and second instars there were no significant differences ($p > 0,5$) between means (Table 3). In terms of total number of aphids consumed, however, the larva covered with wax consumed 178 aphids, which is significantly more than the mean total of aphids (111,2) for 15 other larvae (178 aphids lies outside the 95% confidence limits (94,1 to 167,0) for the mean 111,2). Thus it seems that the build-up of waxes on the head region does not so much reduce predation, but leads to increased numbers of prey being consumed during an extended larval stage. At least two other larvae (fed an uncounted number of aphids / day) had extended larval stages, having larval periods of 90 and 92 days respectively.

TABLE 3

Mean number of aphids eaten/day (comparison of an *M. handschini* larva with the head covered by siphuncular wax and 15 *M. handschini* larvae without the wax); all larvae reared on 5 aphids/day (n = days). Means sharing the same letter show non-significant differences at the p = 0,01 level.

Stage	Wax-covered larva (1)			Wax-free larvae (15)		
	mean	n	SE	mean	n	SE
instar 1	3,5a	8	0,2	3,1a	129	0,1
instar 2	2,6b	13	0,3	2,6b	238	0,1
instar 3	1,9c	62	0,2	3,2d	208	0,1
Total	2,1e	83	0,2	2,9f	575	0,1

The pupal stage

Food type given to larvae appeared to have no significant effect on duration of the pupal stage of *M. handschini* (Table 4).

TABLE 4

Mean duration (days) of the pupal stage of *M. handschini* when the larvae were provided three different food types. Means share non-significant differences at the p = 0,01 level.

Parameter	5 aphids/day	Uncounted aphids/day	Artificial food
mean	34,8	31,6	29,7
n	8	14	12
SE	1,3	2,2	0,7
range	29–38	16–46	27–33

Parasitism

Parasitic wasps were found to emerge from pupae of Chrysopidae collected from *Schinus terebinthifolius* Raddi and from *Citrus* trees in gardens of Pietermaritzburg. These were found to have a ratio (parasitised to non-parasitised) of 1:3. Parasitised pupae were recognised by the small, circular emergence hole in the cocoon. Chrysopidae emerging from pupae taken from the same gardens were identified as *M. handschini*, but the identification of parasitised pupae could not be established. The wasps were *Cheiloneurus orbitalis* Compere (Chalcidoidea: Encyrtidae) and occurred in the sex ratio 2 males to 11 females from one cocoon. Prinsloo (1985) recorded *C. orbitalis* from *S. squamosa* and *Chrysopa* sp.

Rearing recommendations

The lack of success in mating was possibly because of restricted space in the petri-dishes and because of low humidity. The following suggestions for mating, egg production and rearing are however made.

1. Use of paper sleeves within jars 140 mm high x 9 mm in diameter would facilitate easier removal of eggs from jars.
2. The large jar may provide more space for paired imagos to undergo courtship and mating sequences.
3. Mating, oviposition and larval development may also be improved at higher temperatures, as indicated by Brettell (1979 1982).
4. Larvae are best reared on artificial food since this is easier to administer, less labour intensive, and results in no significant decrease in the rate of development. If aphids are to be used as a food source for rearing, a regular diet is preferable to an *ad hoc* supply.
5. Rearing inside petri-dishes or some similar compact container is both easy and desirable.

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